Hells Canyon MIKE 11 Hydrodynamic Model (E.1-4, Chapter 5)

John W. Anderson
AFS Certified Fisheries Scientist
Cold Stream Consulting, P.O. Box 575 Baker City, OR 97814
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I. Introduction

"A one-dimensional (1-D) mathematical computer model has been set up capable of simulating the hydrodynamic (HD, transient water level and discharge variations) for the Snake River from Hells Canyon Dam (RM 247.6) to just upstream of the confluence with the Clearwater River (RM 145.6). The model has been set up using the modeling package MIKE 11, which is a professional engineering software tool for the simulation of hydrology, hydraulics, water quality, and sediment transport in estuaries, rivers, irrigation systems, and other inland waters. MIKE 11, developed by DHI Water & Environment in 1987, is a simulation tool for hydrology, hydraulics, water quality, and sediment transport in estuaries, river, irrigation systems, and other inland waters." (Page 5, Paragraph 1)

"Setting up and calibrating a MIKE 11 HD model requires input of a number of data sets associated with branch definitions, cross sections, boundary conditions, and resistance numbers. For the Snake River model, each of these data sets is explained in this section." (Page 5, Paragraph 2)

II. Conclusions

1. "The model is a single-branch mode, which means that only the Snake River is modeled and none of the tributaries are included in the model."…. "Chainage is the term used in the MIKE 11 model to define the length of the river with units in meters." The numbering system starts at Hells Canyon Dam and runs downstream and cannot be compared with standard river miles because they are not based on the same river thalweg. (Page 2, Paragraph 3)

Response: The BLM agrees with this statement.

2."Cross sections are required at certain intervals along the river. The distance between cross sections needs to be small enough to allow the model to resolve the longitudinal variations in cross section shape and elevation. The following considerations were assessed when cross sections were selected:

1. *Primary river morphology needs to be represented.*
2. *Cross sections are required at locations with recording pressure transducers to allow for comparison of measured and simulated water levels.*

3. *Cross sections are required at locations where other models, such as the 2-D MIKE 21C, need water level information as a boundary condition.*
4. *Cross sections were included at locations requested by various investigators studying botanical, aquatic, and other resources." (Page 5-6, Paragraph 4)*

Response: The BLM agrees with this statement.

3. "The model requires resistance numbers in terms of Mannings's number (n) to be specified for the model as a global value or as local values for sub-reaches."(Page 6, Paragraph 9)

Response: The BLM agrees with this statement.

4. "The MIKE 11 HD model has been calibrated on a very detailed level. Time series of water level measurements were available at 36 locations from Chainage 11863 to 159108 m[meters]." (Page 7, Paragraph 1)

"The calibration process proved that a variation Manning's (n) on a longitudinal scale only was insufficient. Therefore, Manning's (n) was calibrated in two steps: 1) the longitudinal variation was calibrated such that the average discrepancy between simulated and measured water level at each location was approximately zero, and 2) the local vertical variation (variation with discharge) was calibrated one location at a time starting downstream...." (Page 7, Paragraph 3-5)

Response: The BLM agrees with this statement.

5. "The quality and quantity of data available for model development, calibration, and validation are very good. This quality evaluation applies to cross section data, discharge boundary data, and water level data for calibration and validation. The quality and quantity of data, together with the model's simplicity, have allowed for the development of a highly accurate MIKE 11 1-D hydrodynamic model. In general, the accuracy of the model is ±15 cm or better on water surface elevation." (Page 11, Paragraph 4)

Response: The BLM agrees with this statement.

6. "The quality and quantity of data, together with the model's simplicity, have allowed for the development of a highly accurate MIKE 11 1-D hydrodynamic model. In general, the accuracy of the model is ± 15 cm or better on water surface." (Page 11, Paragraph 4)

Response: The BLM agrees with this statement.

7. "Improving the model's accuracy significantly would require that a very large amount of additional data be collected and probably that the model be extended to include rainfall runoff and snow melt processes from smaller subcatchments along the Snake River."…. "The accuracy of the 1-D model also has to be judged against the accuracy of models applying results from the 1-D model. Such models include those for water

quality, sediment, and habitat. The accuracy of these models would probably not justify significant effort into improving the 1-D model." (Page 11, Paragraph 6)

Response: The BLM agrees with this statement.

III. Study Adequacy

The study appears to be adequate to model the Snake River hydrodynamics in the Hells Canyon Reach.

IV. BLM Conclusions and Recommendations

Conclusions

1. The hydrodynamics study has been calibrated using data gathered by the applicant and appears to be accurate enough to measure transient water levels and discharge variations in the Snake River below Hells Canyon Dam.
2. The model is accurate to within approximately ± 15 cm (approximately 6 inches) of river elevation. This level of accuracy is thought to fit within the needs of the other models that will use the information.

Recommendations/Comments

1. A highly qualified hydrologist should review the potential ramifications of an accuracy of plus or minus six-inches in river stage as it will apply to BLM resources. The attenuation of the Snake River as it passes through BLM lands below the confluence with the Salmon River should flatten the ramping surges considerably. A study by the State of Washington recommended ramping rates of less than 2-inches per hour to protect aquatic resources (Hunter 1992). If the MIKE 11 model is only accurate to within 6-inches, it would probably be difficult to model a ramping rate lower than 6-inches.